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ABSTRACT

This report presents a brief history of the development of telecommunication from Samuel Morse's invention of electromagnetic telegraph in 1838 to the present. Technological advancement is examined in the development of wire telegraph, ocean cable telegraph, wire telephone, radiotelegraph, radiotelephone, AM (amplitude modulation) and FM (frequency modulation) broadcast, television broadcast, color television, pay television, educational broadcast, cable television, and other radio uses. Also discussed is the role of the Federal Communications Commission (FCC) in regulating broadcast and special radio services after 1934. (SC)

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A Short History of Electrical Communication

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A Short History Of Electrical Communication

EARLY COMMUNICATION

The earliest method of distance communication was by runners who carried oral or written messages. After man domesticated the horse, riders were able to convey messages faster and farther.

For signaling purposes, primitive people used drum, fire, and smoke. Torches and fire towers figured in the Greek and Roman military campaigns. Agamemnon sent the news of the fall of Troy to his wife by flares along the way. Cyrus, king of the Persians, stationed men with strong lungs on hilltops to relay orders through hide megaphones. During the Crusades, Saladin dispatched messages by pigeons.

The ancients employed burnished metals to reflect the sun's rays for daytime signaling. Signal flags by day and flashing lights at night also were used.

Andrew Jackson fought the British at New Orleans after peace had been reached in the War of 1812 because of a lack of speedy communication to let him know of the war's end. Similarly during the Civil War, a Confederate raider destroyed Yankee whaling ships in the Arctic two months after Lee surrendered.

The colorful pony express required 10 1/2 days to carry mail from St. Joseph, Mo., to San Francisco.

Before the advent of the railroad, it took 44 hours for stagecoaches to carry news from Washington to New York City. Express riders cut this down to 20 hours. Trains now make the trip in 3 hours and jet planes in less than an hour. Trains have crossed the continent in 2 1/2 days and jet planes now make the trip in 5 hours.

In 1492 it took Columbus 70 days to reach the New World. Centuries later American clipper ships crossed the Atlantic in 2 weeks. Steamships have made the trip in 3 1/4 days, and jet passenger planes now span the ocean in about 6 1/2 hours.

However, telephone and telegraph are able to bridge the continent or sea almost instantaneously.

At the turn of the century, radio was confined to wireless telegraph, largely for marine purpose, and code communication for comparatively short distances. Today radio has many aural and visual communication uses on land, on the sea, and in the air.

That radio no longer is earthbound is evidenced by the development of space communication. Global telephone, telegraph and television services have been expedited and expanded by relay via space communication satellites. United States participation in such a system was authorized by Congress in 1962.

WIRE TELEGRAPH

Invention of the steamboat and locomotive greatly reduced the time element in communication. But it remained for the telegraph to strengthen our national life and unity.

The principle of the electromagnetic telegraph was developed by Samuel F. B. Morse. While a professor of arts and design at New York University in 1835, he proved that signals could be transmitted by wire.

As in the case with many notable inventions, he had difficulty in arousing interest. He gave a public demonstration in 1838, but it was not until five years later that Congress appropriated $30,000 to construct an experimental telegraph line from Washington to Baltimore.

Early the next year 1844, members of Congress witnessed the sending and receiving of messages over a part of the line. Before the line had reached Baltimore, the Whig party held its 1844 national convention there and, on May 1, nominated Henry Clay. This news was hurried to Annapolis Junction (between Washington and Baltimore) where Morse's partner, Alfred Vail, wired it to the capital. This was the first news dispatch carried by electric telegraph.

"What hath God wrought?" sent by Morse from the old Supreme Court chamber in the United States Capitol to his partner in Baltimore, officially opened the completed line on May 24, 1844.

Three days later the Democratic National Convention met at Baltimore. Van Buren seemed the likely choice, but James K. Polk won the nomination. When this news was telegraphed to Washington, skeptics refused to believe it. Only after persons arriving by train from Baltimore confirmed the report, were many convinced of the telegraph's value.

Morse and his associates obtained private funds to extend their line to Philadelphia and New York. Small telegraph companies sprang up in the East, South, and Midwest. Dispatching of trains by telegraph started in 1851. Western Union commenced business the same year. It built the first transcontinental telegraph line in 1861, mainly along railroad rights-of-way.

The telegraph provided speedy communication at the time the West was being opened. Together with the railroad, the telegraph built up communities, opened markets, and promoted commerce.

The original Morse telegraph printed code on tape. However, in the United States the operation developed into sending by key and receiving by ear. A good Morse operator could transmit 40 to 50 words a minute. Automatic transmission, introduced about 1914, handles more than twice that number a minute.

In 1913 Western Union developed multiplexing, which made it possible to transmit eight messages simultaneously over a single wire (four in each direction). Teleprinter machines came into use about 1925. Varioplex, introduced in 1936, enabled a single wire to carry 72 transmissions at the same time (36 in each direction). High-speed switching systems date from 1937. Two years later Western Union introduced the first of its automatic facsimile devices. In 1959 Western Union inaugurated Telex, which enabled subscribers to the teleprinter service to dial each other directly.

Until 1877, all rapid long-distance communication depended upon the telegraph. In that year, however, a rival developed with the advent of the telephone. Patent litigation between Western Union and the infant telephone system was terminated in 1879 by an agreement that largely separated the two services.

In 1881, the competitive Postal Telegraph system entered the field. For economic reasons, Postal was merged with Western Union in 1943. Today only one company--Western Union--offers a nationwide telegraph service. Some independent telegraph companies exist, but they are small and mostly serve railroads or particular industries in limited areas.

OCEAN CABLE TELEGRAPH

Ocean cable telegraph--a sea-going extension of the land telegraph system to link islands and continents--also was pioneered by Morse. In 1842, over an insulated copper wire submerged in New York harbor, Morse demonstrated that electrical impulses could be sent under water. It remained for Cyrus W. Field to make the submarine cable practical.

With capital obtained from private subscriptions in New York and London and, in part, appropriated by the British and United States Governments, an attempt was made in 1857 to lay a cable under the Atlantic Ocean. The cable broke after 355 miles had been laid out by a ship operating from Ireland. The following June, another attempt failed. A cable was successfully laid the next month but it soon became inoperative. Another cable-laying effort, in 1865, proved futile.

On July 27, 1866, the steamship "Great Eastern" completed laying a new cable from Ireland to Newfoundland. Returning to mid-Atlantic, the ship located and raised the cable used in the 1865 attempt, spliced it, and extended it to Newfoundland, where it was landed on September 8. Thus, America and Europe were linked by two cables. Other ocean cables followed.

Through telegraph cables, international commerce was stimulated and the exchange of news became a matter of minutes instead of weeks.

Ocean cables were operated by manually repeating the messages along the route. In 1921 "regenerators" were developed for direct transmission between terminals. Less that 300 letters a minute could be sent over the original transatlantic cable. Modern "Permalloy" cables have a capacity of about 2,400 letters a minute.

WIRE TELEPHONE

"If I can get a merchanism which will make a current of electricity vary in its intensity, as the air varies in density when a sound is passing through it, I can telegraph any sound, even the sound of speech."

So declared Alexander Graham Bell in 1875 while experimenting with his "harmonic telegraph." On June 2 of that year, by fashioning a makeshift diaphragm, this teacher of the deaf discovered he could hear over a wire the sound of a twanging clock spring.

Nine months later--on March 10, 1876--Bell transmitted the first complete sentence heard over a wire. What he said was," Mr. Watson, come here, I want you." It was received by his associate, Thomas A. Watson, in an adjoining room of their tiny Boston laboratory.

United States Patent No. 174,465, issued to Bell in 1876, became recognized as the "most valuable patent." Yet early efforts to popularize the telephone met with disappointment. Though people paid to hear Bell lecture on "the miracle discovery of the age," for a time they seemed unaware of it possibilities.

However, 1877 saw construction of the first regular telephone line--from Boston to Somerville, Mass. At the close of 1880 there were 47,900 telephones in the United States. The following year brought telephone service between Boston and Providence. Service between New York and Chicago started in 1892, and between New York and Boston in 1894. But transcontinental service by overhead wire was not inaugurated until 1915.

Early telephones were leased in pairs. The subscriber had to put up his own line to connect with another. The first switchboard was set up in Boston in 1877. The first regular telephone exchange was established in New Haven in 1878. Early switchboards were manned by boys.

In the early days, many cities and towns had rival telphone systems. Philadelphia was the last major area to give up dual service, doing so in 1943.

The first Bell telephone company started in 1878. It developed into the American Telephone and Telegraph Company (AT&T), incorporated in 1885. AT&T and its subsidiaries comprise the Bell System which provides a variety of communication services. Some 1,640 independent telephone companies also operate. Most of them connect with the Bell System.

Toward the close of the 19th century the myriad of overhead telephone wires in large cities became such an obstacle to effective fire fighting, and were so subject to snow and sleet damage that it was necessary to develop sturdier overhead cables. In 1888, 100 wires could be combined into a large cable; today more than 4,000 strands can be encompassed in a cable the size of an adult's wrist.

Experiments with underground telephone cable began in 1882, but it was not until 1902 that the first long-distance buried cable was placed in operation--between New York and Newark, N. J. The first cross-continent underground cable line was opened in 1942.

Submarine telephone cables have long connected this country with Cuba. The first transatlantic telephone cable--connecting Newfoundland with England--was opened in 1956. Later that same year a submarine telephone cable from the State of Washington to Alaska was put into operation. Hawaii was linked by telephone cable with the mainland in 1957, and a telephone cable to France began operation in 1959. Seven telephone cables now link North America and Europe.

The dial telephone was invented by Almon B. Strowger, a Kansas City undertaker, in 1889. The first dial exchange was installed at La Porte, Ind., in 1892. Most telephones now are dial operated.

The first coaxial cable experiment opened between New York and Philadelphia in 1936. One pair of coaxial units can carry simultaneously 1,860 telephone conversations or 600 conversations and two TV programs. Each of these 1,860 voice pathways also can be equipped to provide up to 18 telegraph circuits. Commercial service was inaugurated between Stevens Point, Wis., and Minneapolis in 1941. Coast-to-coast service was inaugurated in 1951 when the Japanese Peace Conference in San Francisco was televised.

Few radio broadcasts travel through the air exclusively, many are sent over telephone wires.

RADIOTELEGRAPH

In the 1860's, James Clerk Maxwell, a Scottish physicist, predicted the existence of radio waves, and in 1886 Heinrich Rudolph Hertz, a German physicist, demonstrated that rapid variations of electric current could be projected into space in the form of radio waves similar to those of light and heat. A patent of a wireless system was issued in the United States as early as 1872.

But it remained for Guglielmo Marconi, an Italian inventor, to prove the feasibility of radio communication. Marconi sent and received his first radio signal locally in Italy in 1895. In 1899 he flashed the first wireless signal across the English Channel and two years later received the letter "S", telegraphed from England to Newfoundland. This was the first successful transatlantic radio transmission. Marconi also sent the first eastward transatlantic radiotelegraph message in 1902.

These activities aroused world interest. Sea disasters proved the new medium to be an effective aid in rescue work, as well as for communicating between ships and between ships and shore points, and a number of ocean liners installed wireless equipment. In 1899 the United States Army established wireless communication with a lightship off Fire Island, N. Y. Two years later the Navy adopted a wireless system. Up to then, it had been using visual signaling and homing pigeons.

The first international wireless conference was held at Berlin in 1903.

The first radio distress call from an American vessel (a Navy relief ship) occurred in 1905. But a radio operator named Jack Binns made world news in 1909 when he remained at his post on the stricken steamship Republic to summon aid with the British radio distress call "C Q D". Later that same year the S. S. Arapahoe brought help with "SOS," which was adopted as an international radiotelegraph distress call in 1906 and is still in use. ("Mayday" was adopted in 1927 as the international distress call for radiotelephony.) In 1912 the ill-fated Titanic also resorted to wireless.

By international agreement in 1927, the alphabet was apportioned among the nations for basic use in radio calls to identify both the nationality and the type of radio stations.

In 1901, radiotelegraph service was inaugurated among five Hawaiian Islands; in 1903, a Marconi station at Wellfleet, Mass., carried an exchange or greetings between President Theodore Roosevelt and King Edward VII; in 1905 the naval battle of Port Arthur in the Russo-Japanese war was reported by wireless, and in 1906 the U. S. Weather Bureau experimented with radiotelegraphy to speed notice of weather conditions. In 1909, Robert E. Peary, arctic explorer, radiotelegraphed: "I found the Pole;" in 1910 Marconi opened regular American-European radiotelegraph service which, several months later, enabled an escaping British murderer to be apprehended on the high seas; and in 1912 the first transpacific radiotelegraph service linked San Francisco with Hawaii.

Overseas radiotelegraph service developed slowly, primarily because the initial use of spark and arc sets were unstable and caused much interference. The Alexanderson high-frequency alternator and the De Forest tuber resolved many of these early technical problems.

During the First World War, governments began using radiotelegraph to keep abreast of events and to direct the movement of troops and supplies. World War II demonstrated the value of radio and spurred its development and utilization for peacetime purposes. Radiotelegraph circuits to other countries enable persons almost anywhere in the United States to communicate with practically any place on the globe.

Pictures have been transmitted by radio since 1923, when a photograph was sent from Washington to Baltimore in a test. The first transatlantic radiophoto relay came in 1924 when the Radio Corporation of America beamed a picture of Charles Evans Hughes from London to New York. RCA inaugurated regular radiophoto service in 1926.

At present there is no domestic all-radiotelegraph service on a national basis. Two radio communication companies once had domestic networks connecting certain large cities, but these were closed in World War II and were not reopened. However, microwave and other developments make it possible for domestic telegraph communication to be carried in substantial part over radio circuits. In 1945 Western Union established the first microwave beam system, connecting New York and Philadelphia. This has since been extended and is being developed into a coast-to-coast system. Over present links Western Union can transmit about 2,000 telegrams simultaneously in each direction.

RADIOTELEPHONE

The first time the human voice was sent by radio is a subject for debate. Claims to that distinction range from "Hello Rainey" spoken by Nathan B. Stubblefield to a partner in test near Murray, Ky., in 1892, to an experimental program of talk and music by Reginald A. Fessenden of Brant Rock, Mass., in 1906, which was heard by radio-equipped ships within several hundred miles.

In 1915 speech was first transmitted across the continent--New York City to San Francisco--and across the Atlantic Ocean--from Naval radio station NAA at Arlington, Va., to the Eiffel Tower in Paris. There was some experimental military radiotelephony in World War I between ground and aircraft.

The first ship-to-shore two-way radio conversation occurred in 1922, between Deal Beach, N. J., and the S. S. America, 400 miles at sea. However, it was not until 1929 that high seas public radiotelephone service was inaugurated. At that time telephone contact could be made only with ships within 1,500 miles of shore. Today it is possible to telephone nearly every large ship wherever it may be on the globe.

Commercial radiotelephony linking North America with Europe was opened in 1927, and with South America three years later. In 1935 the first telephone call was made around the world, using both wire and radio circuits.

Until 1936, all American transatlantic telephone communication had to be routed through England. In that year a direct radiotelephone circuit was opened to Paris. Others to other countries followed. Telephone connection by radio and cable is now possible with more than 180 foreign points.

Microwave telephone transmission was first sent across the English Channel in 1930. A microwave telephone system, between Boston and New York, went into operation in 1947. The first overseas telephone call from a moving automobile was made from St. Louis to Honolulu in 1946.

BROADCAST

It was not until after World War I that regular broadcasting began. The first system used was AM (amplitude modulation).

AM BROADCAST

Licensing of broadcast stations on a regular basis began in 1921 with WBZ, Springfield, Mass., the first station licensed. Some broadcast stations developed from experimental operations prior to that date. A pioneer in this respect was KDKA, Pittsburgh.

Experimental network operation over telephone lines existed as early as 1922. President Coolidge's message to Congress was broadcast by six stations in 1923. In 1926 the National Broadcasting Company started the first regular network with 24 stations. Its first coast-to-coast hookup was in 1927. In that year the Columbia Broadcasting System was organized. The first round-the-world broadcast occurred in 1930.

Before 1923, radio broadcast was localized. Today, through telephone lines, coaxial cable, microwave, and other relay means, the same live program can be sent over many stations at the same time, or by recordings (videotape and film in the case of TV), so the same program can be used at times to suit programing schedules of individual stations.

FM BROADCAST

Though a patent on frequency modulation (FM) was issued in 1902, the principle of FM had been known previously. However, its advantages for broadcasting were not developed until shortly before World War II. Largely as a result of developmental work by Edwin H. Armstrong in the 1930's, the Federal Communications Commission in 1940 authorized commercial FM broadcasting to start January 1, 1941.

There was no "first" individual commerical FM authorization because, on October 31, 1940, the Commission granted construction permits to 15 stations simultaneously. The first licensed commercial FM station was WSM-FM, Nashville (May 29, 1941), which operated until 1951.

To enable FM broadcasters to obtain additional revenue, the Commission in 1955 authorized them to provide a supplemental "background music" service to subscribers. The signal is, in effect, "piggy-backed" on regular programs for reception on special sets in stores, factories, etc.

In 1961 the Commission authorized FM stations to engage in stereophonic broadcast. This involves dual transmission and reception to give a more realistic effect to music and other sound.

TV BROADCAST

The beginning of visual radio has been traced to 1884 when Paul Nipkow, a German, patented a scanning disk for transmitting pictures by wireless. In the United States Charles F. Jenkins began study of the subject about 1890. Rignoux and Fournier conducted "television" experiments in France after the turn of the century. In 1915 Marconi predicted "visible telephone." In 1925 Jenkins demonstrated his mechanical TV apparatus. A year later there were experiments by E. F. W. Alexanderson, Philco T. Farnsworth and John L. Baird.

An experimental TV program was sent by wire in 1927 between Washington and New York by the Bell Telephone Laboratories. The next year an outdoor pick-up was tested. Large screen TV was demonstrated in a New York theater in 1930.

Seventeen experimental TV stations were operating in 1937. An experimental mobile TV station was placed in use that year. The first United States President seen on TV was Franklin D. Roosevelt, when he opened the New York World's Fair in 1939.

In 1939 the Milwaukee Journal filed the initial application to broadcast TV programs on a commercial basis. As a result of a hearing in 1940, the Commission authorized commercial TV operation to start July 1, 1941.

Meanwhile, a number of TV stations, which had been operating experimentally, applied for commercial authorization. The first grant for regular TV operation was issued to WNBT, New York, on June 17, 1941, effective July 1 of that year.

As a result of proceedings that started in 1948, the Commission on April 14, 1952, added 70 UHF (Ultra High Frequency) channels to the 12 VHF (Very High Frequency) channels then used for TV broadcast, thus making more than 2,000 channels available for assignment in nearly 1,300 communities throughout the United States and its territories. TV sets made after April 30, 1964, must be able to receive UHF and VHF channels.

COLOR TV

Color television had long been a subject for study and experimentation. In 1928 Baird, in England, demonstrated one system. The next year color was sent over wire in a test at the Bell Telephone Laboratories.

Color TV was considered initially by the FCC in 1941, when it proposed alternative standards for monochrome and color. In 1945 it allocated certain UHF frequencies for experimentation in developing color and high definition black-and-white TV. In 1946 it received a formal proposal for the adoption of color standards.

Proceedings in 1949 and 1950 resulted on October 11, 1950, in the Commission's adopting a color system that required special receivers or adapters. The FCC held the door open, however, for consideration of subsequent developments and, as a result, adopted the present "compatible" color system on December 17, 1953.

SUBSCRIPTION TV

The FCC authorized pay-TV (involving special programs for subscribers) as early as 1950. Five years later it proposed trial of such a service but, because of Congressional committee resolutions, deferred further action until 1959 when it invited applications by commercial TV stations to test toll-TV. The first such grant was made on February 24, 1961, to WHCT, Hartford, Conn. Subscription TV was established as a regular broadcast service on December 12, 1968.

EDUCATIONAL BROADCAST

University engineers helped to construct some of the nation's pioneer AM broadcast stations, and many early broadcast licenses were issued to educational institutions.

By 1925, educational groups held 171 licenses. For various reasons, most of these stations were off the air when the Federal Communications Commission was created in 1934. However, some educational bodies still operate in the AM band, either commercially or without profit.

To encourage the development of noncommercial educational broadcasting, the Commission in 1938 set aside certain AM channels for the exclusive use of educational institutions. Only a few institutions applied, and most later changed to FM when the Commission allocated FM channels for noncommercial educational use, starting in 1941.

As an additional incentive to educational broadcasting, the Commission in 1948 authorized low power (10 watts) for noncommercial educational FM stations.

In its television decision in 1952, the Commission allocated 242 TV channels for noncommercial educational purposes. This later was increased to 655.

The first noncommercial educational TV grant was made July 23, 1952, to the Kansas State College of Agriculture and Applied Science (KSAC-TV), but that station was not built. The first such station to go on the air was KUHT, Houston, in 1953.

CABLE TV

Cable TV was developed initially in the late 1940's in communities unable to receive television signals because of terrain or distance from TV stations. Master antennas were built to pick up broadcast station signals and feed them by cable to subscribers for a fee.

In 1950, there were 70 cable TV operations in the United States, serving 14,000 subscribers. At the close of fiscal 1973 there were almost 3,000 cable systems serving well over 7.25 million homes in some 5,700 communities.

Cable offers clearer pictures than home antennas, particularly for color TV, and can offer larger numbers of channels for TV signals and various other services. Many systems feature separate channels for weather, stock market reports, wire service news, and FM radio. Some cable operators originate their own programs.

The average cable system has 2,200 subscribers. The largest--in San Diego-- has over 57,000; some have fewer than 100. Most systems offer between 6 and 12 channels, the average being 10. Cable TV systems are capable of offering up to 60 different channels. The average monthly fee is $5 for service; installation fees range from gratis to about $100, but the average is $20.

The cable industry had total subscriber revenues estimated at 391 million in 1971. Cable systems are still concentrated in smaller communities; over half of the systems serve fewer than 1,000 homes each. In large metropolitan areas, where reception is a problem because of the "canyons" created by tall buildings, the number of cable subscribers is increasing.

The Commission asserted limited jurisdiction over cable TV in 1962, first establishing rules in 1965 for those systems which received signals by microwave. (Microwave stations have always been FCC licensed.) In 1966, the Commission established rules for all cable systems, whether served by microwave or not. An extensive revision of the rules was adopted February 2, 1972 and became effective March 31, 1972.

OTHER RADIO SERVICES

Amateur radio is almost as old as marine radio. There was some amateur operation at the turn of the century and, in 1912, several hundred self-styled "hams" were in radiotelegraph communication with one another or listening-in on marine telegraph transmissions. The amateur fraternity, which now also uses radio-telephony, has been highly instrumental in popularizing and advancing the radio art.

Police radio is also among the older public safety services. In 1916 the New York City Police Department began operating a radio station to communicate with its harbor patrol boats. The Detroit Police Department experimented with radio communication in 1921, using the call letters "KOP." The first state police radio system was established in 1923 by Pennsylvania. The first construction permit for a two-way police radio system went to Bayonne, N. J., in 1932, but Port Jervis, N. Y., obtained the first license.

Today radio is employed for a wide variety of purposes. In addition to broadcasters and common carriers, the FCC regulates such non-Government radio services as aviation; marine; public safety (police, fire, local government, forestry conservation, special emergency and highway maintenance); industrial (business, manufacturing, forest products, petroleum, power, etc.); land transportation (railroads, passenger buses, trucks, taxicabs, automobile emergency, etc.); disaster communications; research and experimental; and individuals who use radio as a livelihood, hobby or personal convenience (commercial and amateur operators and private citizens).

-FCC-